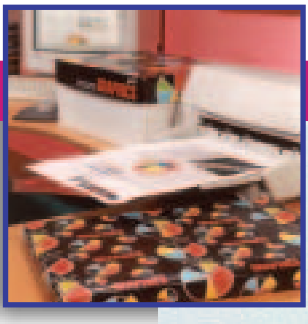
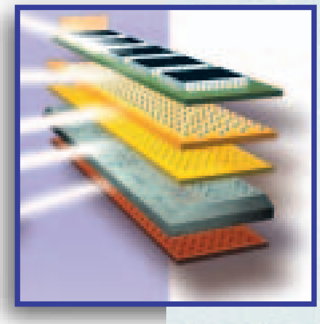




TECHNOLOGY, INKS AND PAPER FOR

# inkjet printing

M-real Digital imaging

## Definition

INKJET PRINTING IS A NON-IMPACT DOT MATRIX PRINTING TECHNOLOGY IN WHICH SMALL DROPLETS OR PARTICLES OF INK ARE JETTED FROM A SMALL APERTURE (IN RAPID SUCCESSION AND UNDER COMPUTER CONTROL) DIRECTLY TO A SPECIFIED POSITION ON THE SURFACE OF A SUBSTRATE, IN ORDER TO CREATE AN IMAGE.

## Contents

# Inkjet Technology Overview

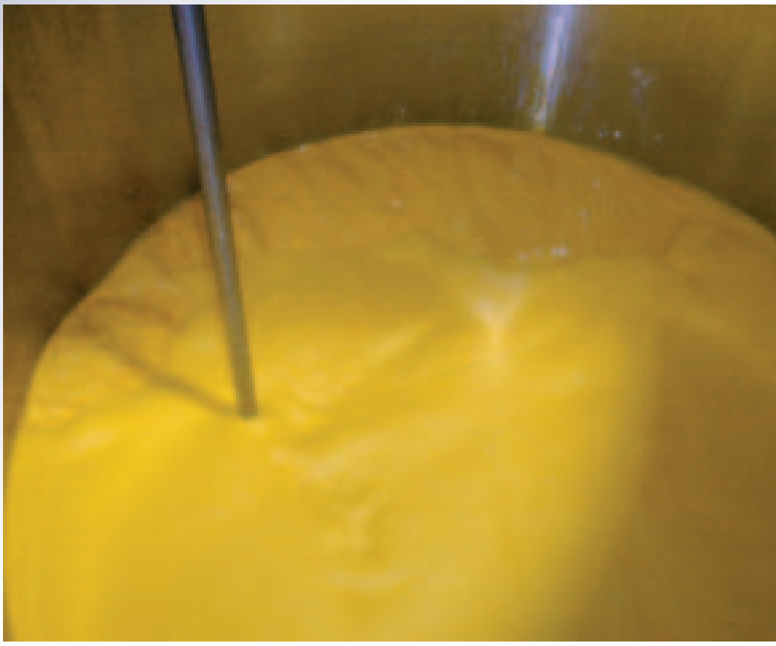
**When inkjet printing first came on the scene print quality was generally unsatisfactory. However, due to developments in hardware (printers), software, inks and substrates, very good printed results can now be achieved. (Improved print quality is not only down to better paper, but a variety of changes in the whole arena)**

In the early days of inkjet print technology development, poor colour image quality due to ink spreading and inter-colour bleeding (that is where the penetration of ink into the paper is too slow to absorb multiple ink drops on the same spot in short intervals) were widely recognized as the critical issues.

The initial solution which has continued to be built upon was the use of special coated media, the design of which takes into account drop volume, evaporation rate, penetration rate, porosity, etc (see Designs on Inkjet Paper, page 11).

But as inkjet print technology was developed and alternative solutions to the use of special coated media were sought, the use of solid (hot-melt) ink was introduced.

The idea being that on contact with the media, the ink solidifies almost immediately, without over-absorption or too much spreading, enabling brilliant colour and image reproduction. These inks have the advantage of being able to print on a wide variety of substrates such as glass and ceramics. However, they do not allow for a very high print resolution, hence at present the technology is not a market leader.



With this potential alternative solution, the door was now open to deeper exploration of the true opportunities of inkjet printing.

Continuous inkjet technology (The process in which a continuous stream of ink droplets are given an electrostatic charge which allows precise placement and frequency of droplets) and drop-on-demand inkjet technology (The procedure in which droplets of ink are forced through a nozzle in a controlled fashion, rather than in a continuous stream), soon became the two primary categories (see Chart 1), spawning their own technology sub-divisions. However, drop-on-demand is at present the most widely used technology with the vast majority of applications being printed using this method.

## Continuous inkjet

Continuous inkjet – perhaps most widely used in the industrial coding, marking and labelling markets - can be designed using a binary or multiple deflection system.

Put simply, with a binary deflection system some of the ink-drops are charged and some are uncharged. It is the charged drops that fly directly onto the media, while the uncharged drops are 'deflected' into a gutter for recirculation. Whereas with a multiple deflection system (also known as raster imaging) the design is essentially reversed, so while the uncharged ink-drops fly directly into the gutter for recirculation, the charged drops are 'deflected' onto the media at different levels.

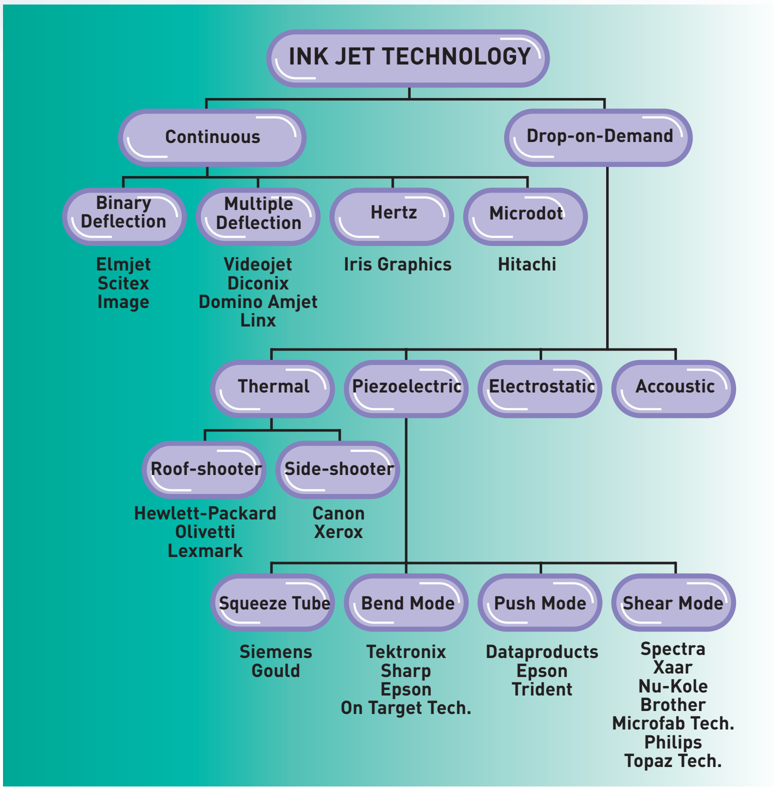



**Chart 1**

Meanwhile, another continuous inkjet concept - the Hertz concept (named after Professor Hertz of the Lund Institute of Technology in Sweden) - can be given separate classification because of its unique way of obtaining gray scale through a burst of small drops. By varying the number of drops laid down, the amount of ink volume in each pixel was controlled by Hertz, therefore the density in each colour could be adjusted to create the gray tone desired, making this ideal technology for high quality colour images at a stage where drop-on-demand quality could not really compete.

## Drop-on-demand

But today, drop-on-demand technology can readily compete, and the majority of activity in inkjet printing currently available utilises one of two drop-on-demand methods: thermal and piezo (or piezo-electric). That is to say that the printing devices supplied by most of today's manufacturers are equipped with either thermal or piezo print heads. This is mainly due to the cost effectiveness of this technology over continuous inkjet.

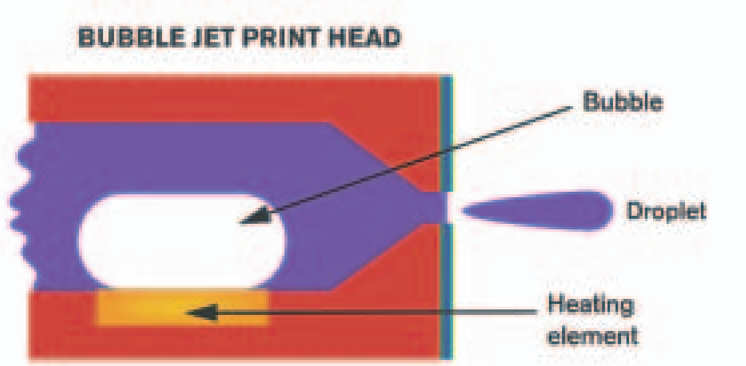
Thermal inkjet print heads receive signals from the control unit, which causes an internal heating device to heat up rapidly and boil the ink present to form a bubble. The heat increases until the bubble bursts and forces the droplet out through the nozzle onto the substrate at high speed. Droplet size may vary from half to full size by heating one or two elements respectively.

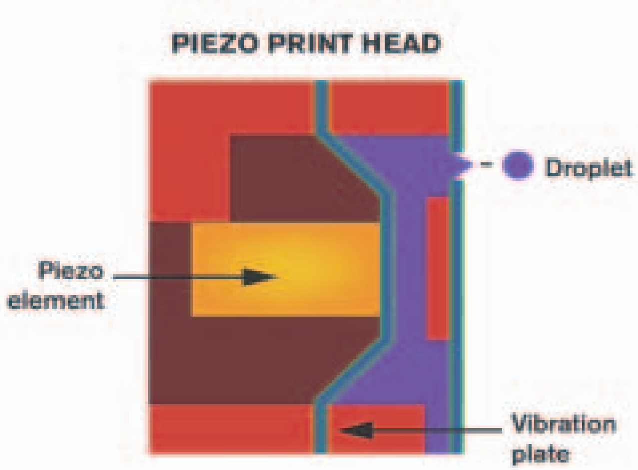
Piezo processing on the other hand, works through the piezoelectric effect. Here, currents pass through piezoelectric crystals or ceramic chambers. This causes the chambers to change shape, which squeezes ink from the nozzles. To produce larger droplets the voltage must be increased which displaces more ink, resulting in a larger droplet. Manufacturers have also experimented more recently with acoustic (also referred to as airbrush) and electrostatic inkjet, but these technologies are still very much in the developmental stage and few commercial products employing them are yet available.

# Heads, Modes and Nozzles

**A thermal inkjet print head is equipped with a resistor, which heats the ink using electricity. The vapour inside the print head's firing chamber expands and pushes the ink out of the nozzle, while the remaining vapour bubble collapses after cooling and sucks new ink into the firing chamber. Through changing the heat energy, the ink-drop size can be tuned according to the application required.**

The main drawback with thermal inkjet print heads is that they have a shorter lifetime. Problems can be caused either through the collapse of the vapour bubble - creating a rapid thermal shock, which can cause damage to the print head - or through early drying of the heated ink in the nozzle. The ink formulation, therefore, usually has to be adapted to help the print head withstand any thermal shock and to minimize any such kogation.




**Not so with piezo inkjet technology, where the electrically charged piezoelectric crystal pressurises the firing chamber in the print head and pushes the ink out. Even though an electric pulse is utilised, it essentially triggers a mechanical 'jetting' process, so vapour bubbles do not have to be generated and the ink is not subject to thermal shock.**

This gives more flexibility in the inks that can be used, such as water based and solvent based ink types, and the ink viscosity can be higher, so the risks of kogation are reduced. It has also become easier now to develop special inks for substrates that have special requirements (see Putting the Ink into Inkjet, page 6). Besides, the piezo print head is more resistant to aggressive chemicals. Finally, a major advantage of piezo is the possibility of making smaller units, resulting in more nozzles per print head, which allows a higher resolution of print to be achieved.

## Print head configurations

Inkjet technology is used in many different architectures and with different operating principles, depending on the configuration of its print heads. With thermal inkjet technology, for example, the print head can be a roof shooter, with an orifice located on top of the heater, or a side-shooter, where the orifice is located on the side nearby the heater.

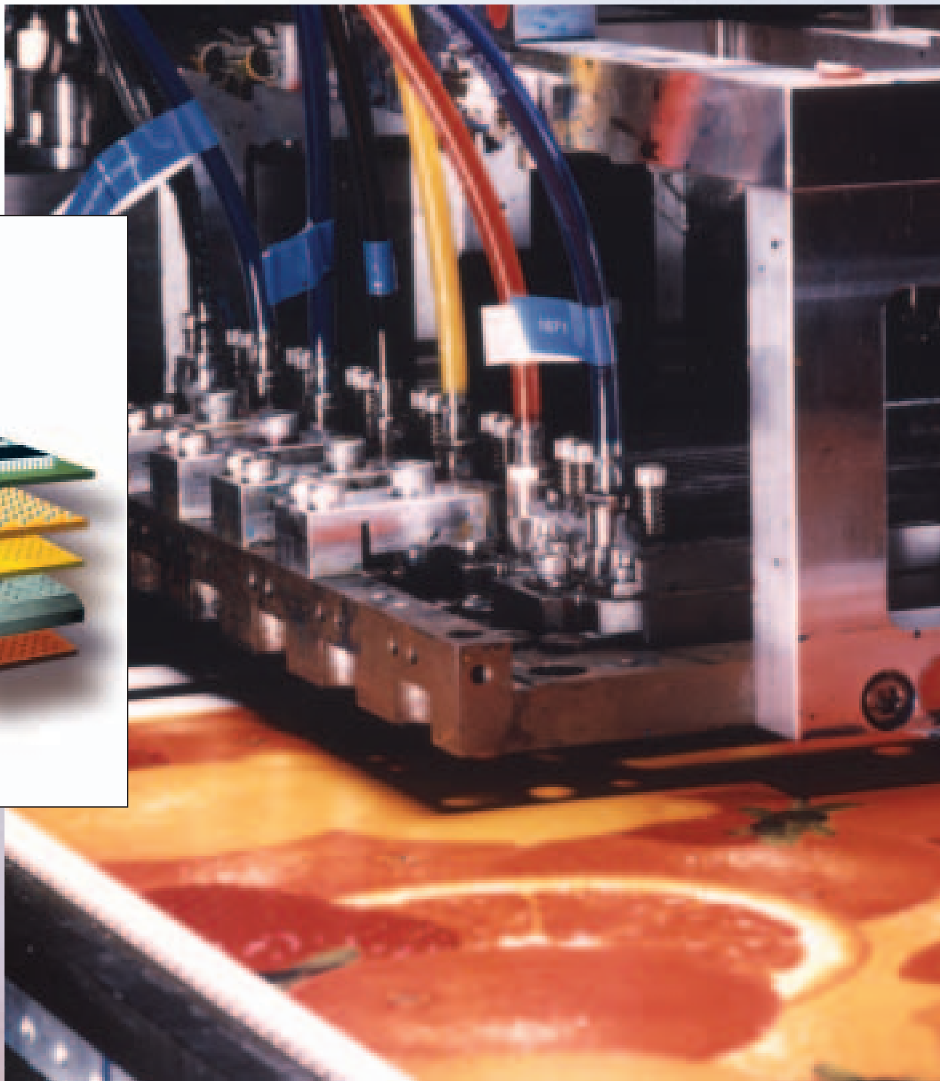
For piezo, there are four main types of print head configuration - squeeze, bend, push, and shear – dependent on what is called, the piezoceramic deformation mode.

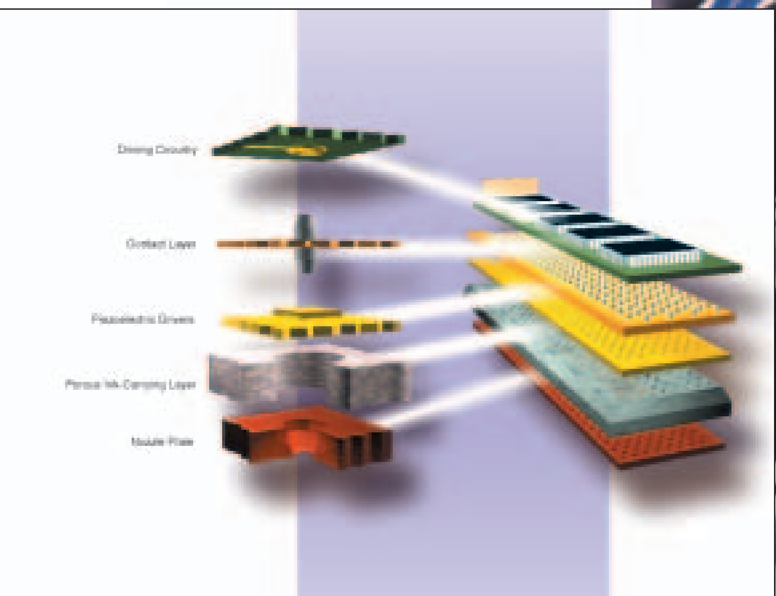
A squeeze-mode design usually has either a thin tube of piezoceramic surrounding a glass nozzle, or a piezoceramic tube cast in plastic that encloses the ink channel.

In a typical bend-mode design, the piezoceramic plates are bonded to the diaphragm forming an array of bilaminar electromechanical transducers used to eject the ink droplets.

For a push-mode design, as the piezoceramic rods expand, they push against ink to eject the droplets.

And in a shear-mode print head, the shear action deforms the piezoplates against ink to eject the droplets. Interaction between ink and piezomaterial is one of the key parameters of this design, as currently pioneered by Xaar.





All of these designs and their drop performances ultimately determine the quality and throughput of a printed image. The trend in the industry is in jetting smaller droplets for image quality, generating faster drop frequency through a higher number of nozzles for additional print speed, while inevitably trying to keep the cost of manufacture down. In an attempt to achieve this, what we have seen is the continued miniaturization of the inkjet print head design, where consequently, reliability issues have become even more critical.

## The nozzle

Independent of a print head's configuration, one of the most critical components in a print head design is its nozzle. Nozzle geometry such as diameter and thickness directly effects drop volume, velocity, and trajectory angle. Variations in the manufacturing process of a nozzle plate can significantly reduce the resultant print quality. Image banding is a common result from an out-of-specification nozzle plate. Various nozzle geometries have been designed for inkjet print heads: the two most widely used methods for making the orifice plates being electroformed nickel and laser ablation on the polymide (other known methods include electro-discharged machining, micro-punching, and micro-pressing).

Because smaller ink drop volume is required to achieve higher resolution printing, the nozzle diameter of print heads has become increasingly small. With the trends towards smaller diameters and lower cost, the laser ablation method has become increasingly popular in the manufacture of inkjet nozzles. This trend towards smaller nozzles can more easily be achieved using piezo technology.

### Thermal vs. Piezo Technology

| Thermal | Piezo |
|---|---|
| + Less expensive technology | + Wide range of inks useable |
| | + Modulate drop size -> better resolution |
| - Limited inks useable | + Higher drop rates |
| - Limitations on ink properties | + Longevity |
| | - Limited number of nozzles per row |
| | - Higher costs per nozzle |

# Putting the Ink into Inkjet

**ARGUABLY ONE OF THE MOST CRITICAL COMPONENTS OF INKJET PRINTING IS THE INK USED. INK CHEMISTRY AND FORMULATIONS CAN NOT ONLY DICTATE (IN PART AT LEAST) THE FINAL QUALITY OF THE PRINTED IMAGE - E.G. THE BRILLIANCE OF COLOUR, THE IMAGE'S LIGHTFASTNESS, ETC - BUT AN INK'S VISCOSITY AND OTHER PROPERTIES CAN ALSO HAVE AN IMPACT ON THE DROP EJECTION CHARACTERISTICS AND THEREFORE THE RELIABILITY OF THE PRINTING SYSTEM USED.**

For this reason, many different types of inks have been developed and experimented with, for use in inkjet applications. These include:

## Aequeous/Water-based Inks

Aqueous- or water-based inks are most commonly used in Small Office and Home Office (SOHO) desktop inkjet printers (e.g. the Hewlett-Packard DeskJet, Canon BJC and Epson Color Stylus). In the case of thermal inkjet, due to the basic vapour bubble formation process, water is an obvious material of choice. Viscosity of water-based inkjet inks range from 2 to 8 cps.

### Important Ink Properties

| | | |
|---|---|---|
| **Print quality** | • Brilliant colours<br>• Colour stability | • High colour density |
| **Light fastness** | | |
| **Water fastness** | | |
| **Slow aging** | | |
| **Runnability** | • Surface tension | • Ink formulation flexibility |

When a water-based ink droplet lands on the surface of an uncoated media such as bond, copy, or plain paper, the ink tends to spread along the paper fibres and penetrate into the bulk of the paper. Such ink behaviour lowers colour density and spot resolution on paper. Whilst some evaporation takes place, a water-based ink depends on penetration and absorption for its drying mechanism.

Paper or other media with a coated water-receiving layer can greatly improve both colour density and resolution by controlling the ink spreading and penetration at the coated layer.

## Pigmented/Dye-based Inks

Another major recent development in the inkjet printing industry is the successful implementation and commercialisation of pigmented inks in colour printing applications. Many companies including recognised colour quality leaders like 3M, Dupont and Kodak already have pigmented inkjet ink products on the market.

Dye based inks are made by completely dissolving dyes in a carrier that enables the dye to be easily applied. Dyes are much stronger and produce more colour of a given density per unit of mass. However, one significant advantage of pigment-based as compared to dye-based ink is its colour durability when exposed to light or extreme weather conditions. This feature is critical to applications such as billboards or other large-format displays. Dyes will soak into the paper fibres and spread out more, which means that they are less light fast and fade quicker, often after only 6-12 months, whereas pigmented inks can last several years. Dye inks are also less water resistant, as the pigmented ink's particles tend to get stuck in paper fibres as the ink dries, so only about 5-10% will re-dissolve if splashed with water. This tendency of dye inks to soak into the fibres can also lead to problems with bleed and wicking and result in poor quality printing.

Pigmented inks are formed by suspending small coloured particles in a carrier, as opposed to dissolving them. Particles are coated in a polymer to generate a static charge around the particle to keep them from sticking together. The pigment sits on the surface of the paper more readily than a dye; hence less ink is needed to create the same density of colour and the small particle size allows sharper image detail. However, as compared to dye-base, pigment-based ink has the inherent disadvantage of particle dispersion instability that may lead to nozzle clogging, and with the aforementioned design trend towards smaller nozzle diameter, this could become more of a concern. Pigmented inks also have a lower rub resistance and are more sensitive to scratching.

## Solvent/Oil-based Inks

Solvent-based inks are commonly used in industrial marking or coating applications where the printing is done on a nonporous substrate such as plastic, metal, or glass. Because no absorption or penetration occurs, the printed image relies on quick evaporation of the ink solvent to be fixed onto the substrate.

However, there are several disadvantages to these types of inks, solvent inks tend to emit a strong smell and over time the printed area can smudge. These inks also have environmental and health and safety issues, for example, inks that contain petroleum solvents emit volatile organic compounds (VOCs) into the air. VOCs can be an irritant for printshop workers when present in the form of vapours, and also contribute to the formation of smog. Inhalation of the solvent can cause drowsiness and hallucinations and, amongst other things, can be carcinogenic. Of course, these solvent vapours cause environmental problems when released in to the atmosphere and can be flammable and there is substantial pressure on ink manufacturers to develop solvent recovery and incineration systems but the development of solvent free inks remains the popular option.

Another more recent, non-aqueous ink option is oil-based ink. More often found in large-format inkjet printers (several of which utilize Nu-Kote piezo shear-mode print heads) the use of non-polar oil-based ink minimizes the effect of electrical fields on the ink and print head materials. There are also legitimate claims that with some coated media, oil-based inks enjoy faster drying time and the absence of cockle on paper substrates, when compared with water-based inks.

## Wax/Polymer-based Inks

Solid (hot-melt) ink, as referred to in the Inkjet Technology Overview, is usually solvent-based and is effectively solid at room temperature. This ink is jetted out from the print head as a molten liquid and, upon hitting a recording surface, the molten ink drop solidifies immediately, thus preventing the ink from spreading or penetrating the printed media. The quick solidification feature ensures that image quality is good on a wide variety of recording media.

Inkjet image quality and durability for water-based, solvent and oil-based inks are generally acceptable when they are printed on inkjet papers or coated substrates. But when printing on non-absorbent substrates such as metal, glass and plastic, these types of inks are generally unable to produce durable and sharp images. To solve this, the idea of using UV-curable, wax or polymer-based inks was discussed for a long time. But factors relating to inkjet print head capability, photo-initiator and low-toxicity monomer availability, hindered the progress of UV-curable inkjet ink development. Today, with recognised increases both in the capability of and availability of inkjet print heads, and with UV photoinitiators, monomers and even oligomers readily available at economic scale, successful development of UV-curable inkjet inks is on the horizon.

# Designs on Inkjet Paper

**If what ink is used for inkjet printing is important, so is the choice of stock. The ideal wish-list when looking at desired properties of paper used in inkjet printing, would include:**

- Optimum print colour density (good fixation);
- Fast drying time without paper curl or cockle (fast absorption);
- High brightness;
- Lightfast and waterfast qualities;
- Wet rub and scuff resistance (no ink smearing);
- Lateral ink spread to enhance text resolution and colour-to-colour bleed by controlling the dot diameter. (The resolution specified by a printer can only be achieved through using the right substrate);
- Sufficient stiffness for feeding through printer.

Of these: printed colour density, ink drying time and colour bleed all depend heavily on the coating structure of the paper. Paper or other media with a coated water-receiving layer can greatly improve both colour density and resolution by controlling the ink spreading and penetration at the coated layer.

For this reason, within the past few years, the market for specialty-coated inkjet media has exploded, especially in the home photo quality and large-format inkjet printing areas.

Another important factor in achieving quality prints is resolution. This relates to how much pictorial information a file holds. The DPI (dots per inch), tells us the resolution of an image; the higher the dpi, the higher the resolution and hence the finer the detail of the printed image. High resolution is generally considered to be 1200-5000 dpi.

In conventional printing, variable sized dots are set down in fixed patterns that in CMYK form 'rosettes'. These are formed because the screen is orientated differently for each colour. So screen angle, dpi and dot size all affect the way that the transparent inks overlap and make colours and images in conventional printing. Screen angles are optimised for specific plates, presses, processes, etc., to prevent moiré and maximize sharpness and vibrance.

Unlike commercial four-colour process, most inkjet printing forms images by printing small dots of the same size at varying distances from each other – often overlapping so dot gain is more critical (This is known as stochastic screening). Dot gain relates to the tendency of the dots to print larger than they appear on the original. A drop in print contrast indicates that dot gain is too great – the dots merge and the image loses definition. On press dot gain is normally due to ink spreading as it hits the paper, and is affected by many factors; ink viscosity, substrate absorbency, paper coating and half tone screen ruling (fine and stochastic screen give higher dot gain)

# The questions is ? . . .

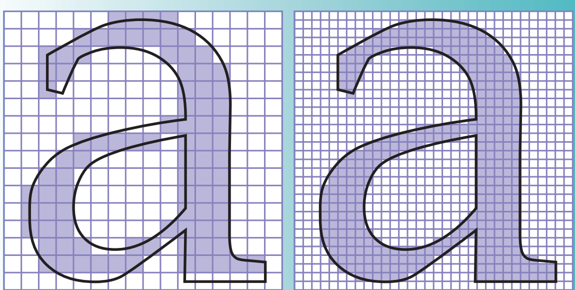
**After a while the image looks like it has a metallic sheen in dark areas**
'Bronzing' occurs when dye-to-dye interactions compete with the dye to substrate interactions. The dyes in the ink aggregate or crystallise on the paper surface, which leads to a loss in optical density. It can be limited by reducing the amount of black in the image.

**Different colours seem to have merged**
Colour to colour bleed is a common problem when the wrong stock is chosen. The ink doesn't dry fast enough and its dyes are not immobilised quickly enough, with the result that they blend together. Bleed does not always happen immediately, but may happen some time after printing, particularly in the case of exposure to heat or humidity or by oil based/solvent based inks over time.

**Inks do not dry fast enough and blend together**

**Edges look jagged**
If the resolution of the file is too low or the enlargement too great then this can lead to 'jaggies', these are where the individual pixels of the image become visible and are especially obvious in the curved parts of the text that have been over-enlarged.

**Low resolution output** | **High resolution output - 2400-3200dpi**

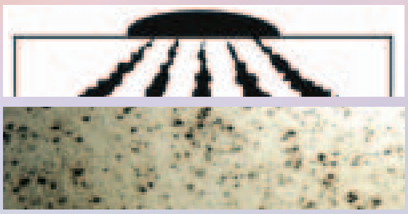


**The eye is very sensitive to 'breaking' of smooth curves. The figure on the right is double the resolution of the figure on the left, it's easy to see that if the resolution is higher a smoother curve can be produced.**

**The image looks very grainy and pixelated, curves have a stepped appearance**
Many images from the web or free CD's can be of low resolution. In general a full-page bitmap file will be several megabytes in size, although the stored version may be smaller if it is compressed (e.g. jpeg).

An important factor in achieving quality prints is resolution. This related to how much pictorial information a file holds. The DPI (dots per inch), tells us the resolution of an image; the higher the dpi, the higher the resolution and hence the finer the detail of the printed image. High resolution is generally considered to be 1500-5000 dpi.

**The ink seems to leak through to the other side of the paper**
This is known as 'strike through' and occurs when the paper has insufficient absorption capacity for the density of ink. – Use a higher grade or heavier coated paper.



**Paper is too adsorbent and ink can be seen on back of sheet**

**The image is not the right colour**
This can have many origins: the colour of the print may well not match that of the screen or the original unless great care has been taken to calibrate each element of the system. The colour of an image can be corrected either in the imaging application or in the printer driver. If you have several images from the same source, e.g. camera, scanner or CD, then they are likely to all have the same characteristics. Images that come from varying sources may need to be calibrated before use.

**The image is too light or dark**
This could be because the original image is very dark, or light, either change this in the application or use the controls of the driver to try to lighten the image. When scanning an image, try to use the white and black point controls to set the range of light and dark for the image. If it doesn't print like the screen image this may be because your screen is not calibrated. Several tools exist to help set up the monitor, these are often shipped either with the image application or with the graphics card.

**The shadow areas look grainy but the rest of the print it OK**
The effect, often referred to as 'coalescence', refers to the way in which the ink is absorbed into the media. Several things can be done to counter it, the most important is to choose the correct print mode in the printer driver. In general terms the highest quality settings available will give the best results. Choose the highest resolution possible, the finest drop size possible and the highest quality media.

**The image appears speckled**
'Mottling' is due to uneven ink density on the sheet and can be caused by: Poor paper formation, poor coating coverage or drying. When using pigmented inks improper ink absorption or binding can cause 'rub off'.

**The media takes too long to dry**
The time taken for a print to dry depends on several factors, i.e. The printer, ink and ink coverage. The amount of ink printed which in turn depends on the density of the image. Photographic and graphical images use much more ink than text. Check your printer settings to avoid the use of to much ink for the image. The temperature and humidity of the room and the amount of air movement also play an important role in determining how long a print needs to dry. High humidity will slow down the drying process. Inkjet media is designed to work best in environmental conditions ranging from 20ºC to 28ºC and 30% to 70% humidity.

For the best results carefully remove the print from the printer once it had finished printing and place it flat in a warm dry environment with good air circulation. Normally a print will dry in several minutes, however if you plan to print on the back it is advisable to wait a couple of hours.

**Sheets stick together when they collect in the output tray of the printer.**
Check you printer setting to avoid the use of too much ink, avoid having multiple prints landing on each other, remove the print once finished and place it elsewhere to dry for several minutes

**The sheet is not flat after drying**
Too much ink has been used causing curl, check you are using the correct material and if you have used the correct printer settings.

**Unprinted material sticks together**
Working or storage conditions for relative humidity are important. See your paper instructions for the optimum storage conditions.

## Factors Influencing Image Quality

| Properties | Key factors to achieving: |
|---|---|
| **Sharpness** | Uniform and circular dots, exact placement, controlled dot gain |
| **Contrast** | Minimal ink penetration into substrate, controlled dot gain |
| **Properties** | **Key factors to avoiding:** |
| **Mottling** | Homogeneous paper, uniform distribution of fibres and fillers |
| **Ink bleed** | Rapid drying through good and even ink absorption |

**The paper won't load into the printer**
Check that the driver is not set to manual loading. Ensure the paper is flat and not creased, that there is nothing obstructing the paper entering the printer such as tears etc. Ensure the paper is correctly positioned on the media tray. Try feeding the paper manually, one sheet at a time or using a different media tray.

**It takes a long time before it prints**
Photo and graphical images can be very large files and take longer to process, be patient and see if it works eventually. If it is just slow this might indicate that you need more memory, or are running low on disk space. Trying to do other tasks in parallel will slow the machine down. Shut down all other applications and try again.

**My printer doesn't print**
Check that everything is turned on and that all cables are attached correctly, if possible use the driver to perform a communication test with the printer. Try printing a test page from the driver. If all of this works, try printing using a different application. E.g. a word-processing package to check the printer/computer communication. Finally, try printing a small image (most packages have tutorial or sample images which are small files), the image may be too complex for your computer and printer to handle. Try printing the document without the image to see if this is the case. If so, reduce the resolution of the graphics as the higher the resolution the more memory and time the process will take. If you are printing several graphical pages or pages with heavy formatting try to print just one or two pages at a time.

**The printer loads more than one sheet at once**
Try putting fewer sheets in the tray and fanning them before loading them, if this fails then try loading them manually one sheet at a time.

# Inkjet's different images

**AS TOUCHED ON THROUGHOUT THIS DOCUMENT, INKJET PRINTING TECHNOLOGIES ARE USED IN A WIDE RANGE OF APPLICATIONS INCLUDING HOME, OFFICE, LARGE FORMAT, INDUSTRIAL, THREE-DIMENSIONAL, MEDICAL, PACKAGING, TEXTILE AND OTHER SPECIALTY PRINTING SECTORS AND EVEN COMMERCIAL WEB-FED PRINT WORK.**


In newly emerging areas like medical imaging and 3-D printing, significant improvement still needs to be made to the print head design and ink formulations in order to fulfil the high expectations of printer reliability and image durability demanded.

But drop-on-demand inkjet's capacity to print vivid colour images at relatively low cost has already led to the technology's particular dominance in both the cutsize, Small Office and Home Office (SOHO) sector and in the large-format colour printer market.

## Applications in Inkjet Printing

| | Market/Application | Key Player |
|---|---|---|
| **Current Markets and Applications:** | Small office/ home office | Hewlett-Packard, Canon, Epson |
| | Office network | Tektronix, Hewlett-Packard |
| | Graphic arts | Iris, Tektronix, Epson |
| | Industrial/postal marking | VideoJet, Marsh, Image, Willet |
| | Large format | ColorSpan, Encad, Hewlett-Packard, Mimaki, Epson |
| **Emerging Markets and Applications:** | Home photo | Hewlett-Packard, Epson, Canon |
| | Multifunction | Hewlett-Packard, Canon |
| | Digital color press | Scitex, ACS, Tektronix |
| | Grand format | Idanit, Vutek, Nur, ColorSpan, Mutoh |
| | Textile | Canon, Seiren, Stork, Toxot |
| | Medical imaging | Iris, Sterling Diagnostic |
| | 3-D printing | 3D System, Z Corporation |

## Cut to Size

In the office network colour printer market, the battle between colour laser and colour inkjet printing technologies is still ongoing: the delicate balance between print speed, image quality, image durability, purchase price and operation cost all key factors.

The facts are that:

- by end 2002, over 50% of the SOHO printer market is expected to have turned to colour - this statistic includes both laser and inkjet printer options, with the latter steadily gaining dominant market share;
- there is a continued decentralisation of office printing away from the photocopier towards personal 'desktop' printers;
- high quality colour documents such as proposals and presentations, previously outsourced to printers and copy shops, are being printed more and more in-house;
- the growing range of digital cameras and desktop scanners has seen widescale escalation of desktop printing of images.

## SOHO Paper Demands

Cut size stock for SOHO printing environments can be split into four main types:
- Glossy coated paper is ideal for photo-realistic imaging, but often considerably more expensive due to the PE coating, the binding systems, the different pigments, namely special pigments which allow high transparence and high absorption and/or the fixation agent.
- Matt coated paper typically has a silica-based coating, but still holds good colour graphics quality.
- Lightly coated multi-function papers are becoming increasingly popular due to the added imaging flexibility they allow at a comparatively low sheet cost, making them ideal for multi-purpose print environments.
- Uncoated surface papers for monochrome printing where colour quality is not even an issue.

### Cut size Applications

- Presentations
- Reports
- Promotional documents
- Leaflets
- Flyers
- Charts
- Direct mail
- Posters
- Letterheads
- Business cards
- Photographs
- Proofs
- CD Covers and labels
- Greeting cards

Broadly speaking then, paper demands for SOHO inkjet printing include:
• Excellent print quality (good fixation of the ink on the substrate)
• Fast ink drying time
• Good light stability
• High dimensional stability (i.e. low or no cockling/curling)
• High ink absorption capability
• Adequate surface friction to enable better feeding
• Good printed opacity (particularly in a duplex printing environment)

# The Larger Chunk

**ANOTHER MARKET SECTOR WHERE INKJET PRINTING HAS MADE HUGE INROADS IN RECENT YEARS IS LARGE FORMAT PRINTING.**

The introduction of wider print heads and multiple arrays coupled with the availability of increasingly high performance inks - UV curing, water-resistant, pigmented inks (see Putting the Ink into Inkjet, pages 8-10) - have brought about a revolution in the large format application capabilities of inkjet. And, as a considerably faster printing technology with a wider colour spectrum (now up to 8 colours) than, for example, screen printing, there has been an understandable explosion of interest in large format inkjet printing systems.

Inkjet's inherent economies of scale and its capacity for photo-realistic image quality at speed and at a reasonable cost per page, have also recently led to an inkjet assault on the world of colour proofing, where optimum colour quality is an essential as distinct from a value-added component (see Colour in Profile, on the next page).

With this and other large format inkjet applications in mind, paper demands for large format inkjet printing centre around:

- Appropriate print quality for a specific application (e.g. CAD paper, photo paper, etc)
- Fast ink drying time
- Good light stability and lightfastness
- High dimensional stability (i.e. low or no cockling/curling)
- High ink absorption capability
- Proper surface friction
- Suitability for hot and cold laminating
- High opacity
- Water resistance

## Large format Applications

- Point of sale displays
- Banners and signs
- Architectural renderings
- Project plans
- Packaging prototypes
- Comps and proofs
- Posters and Photos
- Vehicle graphics
- Trade show graphics
- Maps
- Entertainment industry
- Museums and art galleries
- Wall coverings
- Fine art
- Proofing

# Colour in Profile

**BEFORE EVEN GETTING INTO PRINTED BEHAVIOURAL QUIRKS CAUSED BY THE USE OF DIFFERENT INKS ON DIFFERENT PAPERS, OR HOW THE SAME INKJET DEVICE MAKE AND MODEL CAN PERFORM DIFFERENTLY UNDER CHANGING ENVIRONMENTAL CONDITIONS, LIKE DIFFERING HUMIDITY LEVELS OR TEMPERATURES, IT IS WORTH NOTING TOO THAT COLOURS LOOK DIFFERENT UNDER VARYING VIEWING CONDITIONS.**

This variable is known as metemerism and essentially points to the fact that an optimum digital inkjet colour proof system must deliver 4,000-6,000 colours in a gamut to match offset printing. A seemingly short order if you consider that the human eye can distinguish up to ten million colours in its gamut. But still a significantly tall technology order, even given the recent advances in inkjet.

This is where ICC profiling comes in. The International Colour Consortium (ICC) was established in 1993 by eight industry vendors for the purpose of creating, promoting and encouraging the standardization and evolution of an open, vendor-neutral, cross-platform colour management system architecture and components. The resultant ICC profile format essentially provides a cross-platform device profile format that can be used to translate colour data created on one device into another device's native colour space. Furthermore, embedded ICC profiles allow users to 'transparently' move colour data between different computers, networks and even operating systems without having to worry if the necessary profiles are present on the destination systems.

ICC profiles permit tremendous flexibility to both users and vendors. For example, it allows users to be sure that their image will retain its colour fidelity when moved between systems and applications, assuming the new system is capable of reproducing all the original colours. While it allows an inkjet printer manufacturer to create a single profile for multiple operating systems.

The specification divides colour devices into three broad classifications: input devices, display devices and output devices. For each device class, a series of base algorithmic models are described which perform the transformation between colour spaces. These models provide a range of colour quality and performance results which provide different trade-offs in memory footprint, performance and image quality. The device profiles obtain their openness by using a well-defined reference colour space and by being capable of being interpreted by any ICC operating system or application that is compliant with the specification.

# Jetting Trends

**‘Information is king. The Sunday edition of the New York Times on average contains more information than was printed in the whole of the 15th Century.’ Martha Beck, O Magazine, April 2002)**

In spite of multiple advances in inkjet printing technology over the last decade, all the indications are that the technology is set to grow even more over the coming decade. The advent of the Internet, far from reducing the desire for printed information as initially expected, has actually seen it grow, creating a spiralling demand for PCs and printers in households the world over, bringing with it the capability of desktop ‘on demand’ printing.

As a backdrop to all this, inkjet printer manufacturers are continually looking at new ways of creating a competitive edge. With R&D spending continually being ploughed into means of decreasing drop size and increasing resolution and multi-drop / variable drop technological advances. Continuous inkjet technology, developed by Scitex for example, can already reach speeds of 300 m/min.

Furthermore, through inkjet, outstanding colour print quality at a low price is now possible, with most devices supporting (or are moving towards support of) six-colour printing/proofing capability (CMYK and two additional colours). Similarly, through advances in ink technology and glossy paper grades, photo-realism image quality is now readily attainable.

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